PART E

ASSESSMENT OF CUMULATIVE IMPACTS

CONTENTS:

1 INTRODUCTION

The assessment of cumulative impacts associated with new development projects is an integral part of effective and comprehensive EIA. Cumulative impacts may arise when impacts arising from the emissions, discharges, hazards or other potential effects of a proposed project physically interact with, or are additional to, similar types of impacts of other projects or activities and/or existing background levels of pollution, risk or other environmental effects. In some cases these other projects may also be proposals, such as committed (but as yet unbuilt) developments.

One specific, as yet uncommitted, project which was formally assessed in terms of potential cumulative impacts arising from emissions to air and water is the Waste to Energy Incineration Facility (WEIF); the rationale for the cumulative assessment of the proposed new power station and the WEIF is provided in *Section* 2 below.

Where cumulative impact assessment is required, EIA methodologies have be used which are capable of combining the projected impacts of existing and proposed projects for evaluation purposes, and predicting the likely "worst case" impacts that may arise from the combined influences of these projects.

A wide range of potential cumulative impacts was assessed in this EIA Study as an integral part of the individual technical assessments for the different components of the project. The approaches used for these assessments, and a summary of the results obtained, are described in *Section 3* below.

2 CUMULATIVE ASSESSMENT OF THE POSSIBLE CO-SITING WITH A WEIF

2.1 BACKGROUND

During the Stage 1 EIA of HEC's proposed new power station, the Consultants undertook an assessment of "*the environmental issues which would arise as a consequence of co-siting a WEIF with HEC's proposed new power station.*" The primary purpose of the co-siting assessment was to determine whether the air and water quality impacts associated with the new power station would preclude the development of an adjacent WEIF.

The Stage 1 EIA concluded that co-siting was feasible and that the co-siting of a WEIF with the Lamma Extension power station option did not entail unacceptable impacts, in terms of air and marine water quality impacts.

The *Stage 1 EIA for a New Power Station: Volumes 1 & 2* was endorsed by the Advisory Council on the Environment on 24th February 1998 and appears on the EIA Register (Ref: EIA-130/BC) under Section 15(1)(f) of the Ordinance.

2.2 CUMULATIVE IMPACT ASSESSMENT WITHIN THE NEW POWER STATION EIA STUDY

The EIA Study Brief (ESB-001/1998) for the 1800MW Gas-fired Power Station at Lamma Extension requires the cumulative implications of the WEIF to be incorporated in the air and water quality modelling to be undertaken by HEC's Consultants.

The findings of the detailed cumulative assessment of the air quality impacts are presented in *Section 3.1* below in line with the requirements of the EIA Study Brief. Both the wind tunnel modelling and the PATH modelling demonstrated that there would be no exceedance of the AQOs for SO_2 and NO_2 due to the combined operation of the WEIF, the existing Lamma Power Station and the proposed Lamma Extension.

The cumulative impact assessment for water quality was undertaken for both the construction and operation the Lamma Extension; the results of this assessment are presented in *Section 3.2* below.

These cumulative assessments required the definition and running of additional modelling scenarios to determine whether the requirements of the Air Pollution Control Ordinance (APCO) and the Water Pollution Control Ordinance (WPCO) would be met by the co-siting scenario and to establish whether the development of the Lamma Extension would preclude the subsequent development of an adjacent WEIF. In undertaking these additional model runs, it was acknowledged that the WEIF Lamma Site option was at an early stage of evaluation and that it was one of the four options under consideration by the Feasibility Study Team.

It was further acknowledged that the Feasibility Study Team were unlikely to generate sufficient detailed information on additional impacts to environmental resources such as marine ecology, fisheries, landscape and visual resources or noise and hazards implications to allow a full cumulative assessment to be undertaken at this stage. It was resolved,

therefore, that the cumulative assessment undertaken for the new power station EIA would focus solely on areas where sufficient information was available (ie water and air quality). Further cumulative assessments on the remaining issues would be undertaken as part of the EIA of the WEIF, if the Lamma Site was selected as the preferred option for the facility.

3 CUMULATIVE IMPACT ASSESSMENTS

3.1 AIR QUALITY

3.1.1 Wind Tunnel Modelling

The cumulative impacts on local air quality of HEC's existing and proposed power stations were tested with quantitative tracer gas measurements during the wind tunnel studies of the air quality assessment. Predicted maximum hourly, daily and annual average concentrations were derived at receptors on Lamma Island Ap Lei Chau and Hong Kong South for both sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). The results indicated that there would be no breaches of the Air Quality Objectives (AQOs) with peak load operation in 2012, when the new power station would be fully operational.

The wind tunnel studies also indicated that there would be no exceedances of the AQOs with the additional operation of a proposed waste-to-energy incineration facility (WEIF) at Lamma Island in 2012.

3.1.2 PATH Modelling

The PATH photochemical air quality modelling system was used to identify both the *cumulative* and *incremental* impacts on air quality of the new power station at Lamma Extension, by predicting air quality at hourly intervals throughout the SAR *with* and *without* the emissions from the proposed new facility. The outputs of the model are a true cumulative assessment of emissions from existing and proposed HEC facilities at Lamma, the proposed WEIF, motor vehicles, area sources, industrial facilities, marine vessels and other sources in Hong Kong.

For the selected meteorological condition, the predicted concentrations were at least 50% below the AQOs. As a percentage of the relevant AQOs, the maximum contributions of the proposed CCGT units to levels of NO_2, SO_2 and O_3 anywhere in the SAR were 6.5%, 0.5% and 1.9% respectively. Predicted maximum 24-hour concentrations of SO_2 and NO_2 were also well within the AQOs, and the largest incremental contributions of the CCGT units were 0.4% and 3.7% of the AQOs for SO_2 and NO_2 respectively. Also, the contributions of the new power station to the maximum one-hour and 24-hour levels observed with model were negligible in the locations where those maxima occurred.

Predictions for five other meteorological conditions indicate that cumulative impacts will not cause pollution levels which exceed either the one-hour or 24-hour AQOs, with maximum predicted levels in the SAR falling between 35% and 64% of the Objectives. The maximum incremental impacts of emissions from the CCGT units on one-hour average and 24-hour concentrations are typically very low and tend to occur over the ocean rather than populated areas. Under the simulated condition, contributions to maximum predicted levels are negligible.

Data from the six simulations were combined to produce a weighted average concentration that approximates to the annual average. The assessment indicated

that the highest annual average concentrations of nitrogen dioxide are predicted to occur in the Western Harbour area and to be less than 80% of AQO. The predicted concentration of sulphur dioxide (as shown in *Figure 4.51* of *Part B*) is well within the AQO (about 55%). The increment due to emissions from the CCGT units is 0.8% and 3.3% of the AQOs for SO_2 and NO_2 respectively, and is not predicted to arise at the same location as the peak predicted concentration arising from all sources addressed cumulatively.

3.1.3 *Regional Air Quality Review*

A quantitative assessment of the regional air quality impacts of a new power station was undertaken as part of the Stage 1 EIA. The findings of this earlier assessment were reviewed and updated for the purpose of this detailed EIA Study.

The earlier assessment provided a broad evaluation of the potential regional impacts of atmospheric emissions from the proposed new power station. Emissions and their effects at the regional level were addressed, including consideration of sulphur dioxide, nitrogen dioxide, particulates, acid deposition, visibility and photochemical reactions. A three-dimensional prognostic mesoscale meterological model, the *Lagrangian Atmospheric Dispersion Model* (LADM), was used to model the air quality impacts from the proposed new power station. Major existing and future pollution sources that are conducive to photochemical reactions were included in the simulations, which showed that the predicted maximum ozone (O_3) and NO_2 concentrations in 2012 differ very little, *with* or *without* the proposed power station. From the regional perspective, the contribution of the new power station to maximum NO_2 concentrations in the Pearl River Delta was approximately 1%. The assessment also found that the contributions of HEC power plant emissions to acid deposition in the region would be 3% and 1% for the years 2002 and 2012 respectively.

During the detailed EIA Study, estimates of oxides of nitrogen (NO_x) and SO_2 emissions from all major sources in Hong Kong were updated and projected for the years 2002 and 2012, and pollutant concentrations were re-estimated.

It was found that, the new gas-fired station would contribute negligibly to maximum regional concentrations of O_3, NO_2 and SO_2, since the emissions from an additional power station, compared to the existing emissions in the PRD region, are extremely small. With the introduction of the gas-fired station, HEC's contributions to the PRD regional NO_x and SO_2 concentrations amount to only 1.5% and 0.7% respectively in 2012. There will be a reduction of less than 2% in the predicted O_3 concentration and less than 1% increase in the predicted NO_2 concentration from the new gas-fired power station. The proposed new power station will also help to reduce the overall acid deposition to the region by about 1%.

Hence, it could be concluded that the contributions of the new gas-fired station to regional NO_x and SO_2 are negligible in the context of the emissions from the whole PRD region.

3.1.4 *Greenhouse Gas Emissions*

This assessment included the compilation of a greenhouse gas emissions inventory for all HEC operations, and an investigation of the impacts of proposed greenhouse gas mitigation measures on both existing and proposed

facilities at Lamma. Total emissions were projected to increase from 1990 levels by 80% (5.11 Mt) and 62% (3.97 Mt) in 2002 and 2012 respectively, illustrating the beneficial impact of gas-fired operation after 2002 despite total electricity generation in the year 2012 being 2.57 times that of 1990 . Estimated greenhouse gas emissions *per unit of energy produced* were predicted to fall from 1990 levels by 37% in 2012.

The impacts of mitigation measures in the areas of increased production and distribution efficiency, use of fuels with intrinsically low greenhouse gas emissions, improved consumption efficiency, reduced fugitive emissions, and carbon sequestration, were quantified in the assessment. A cumulative gain of 6.5 million tonnes of emissions of CO_2 equivalent will be achieved in 2012 as a result of these measures (a 39% reduction in overall emissions), leaving an estimated total of 10.3 million tonnes for HEC operations in that year.

HEC is committed to adopting all practical measures for reducing its Greenhouse Gas (GHG) emissions, especially from the proposed 6 x 300 MW gas-fired power station. Measures such as base-load shifting to gas units, gas flaring and participation in afforestation programmes will be employed. However, since both Hong Kong's population and economy continue to grow substantially in the next decade, electricity consumption and GHG emissions will inevitably increase.

3.2 WATER QUALITY

3.2.1 *Hydrodynamic Modelling*

The hydrodynamic assessment for the Lamma Extension reclamation considered the combined impacts of the Lamma Extension and WEIF reclamations. Modelled changes at the tidal currents and discharges were found to be relatively small, and it was concluded that the overall flushing characteristics of the area would not be adversely affected by the two reclamations.

The assessment of impacts on the *sedimentation* regime was also based on the hydrodynamic modelling results, and concluded that there would be no significant changes to the sedimentation regime as a result of reclamations constructed for the Lamma Extension and WEIF projects.

3.2.2 *Sediment Dispersion Modelling*

The cumulative impacts of dredging for the Lamma Extension and other projects, such as dredging for Container Terminal 9 and sand winning and backfilling at the South Tsing Yi Marine Borrow Area (STY MBA), were considered in the water quality assessment. Total suspended sediment concentrations for these cumulative scenarios were found to breach the WQOs. However, it was found that further mitigation of the Lamma Extension reclamation construction would not reduce the predicted impacts to below acceptable levels as the Lamma Extension reclamation contributed less than 10% to the total suspended sediment concentrations. Coordination between the monitoring for the various projects was recommended to determine the responsibility for any observed impacts and to ensure that mitigation would be applied where necessary.

3.2.3 *Thermal Impact Assessment*

Assessment of the thermal discharge in cooling water considered the cumulative impacts of the existing and proposed power stations and the WEIF, and found

that the water quality objective (no more than 2°C rise) was met at each of the SRs.

3.3 *NOISE*

Operational noise levels were predicted for the combined impacts of both the existing and proposed power stations. The new plant will generally give rise to levels below those of the existing plant at this location. Under the quietest operational states of the existing plant, cumulative plant noise levels may be increased slightly due to new plant operation, but at the higher operational loads, the new plant will not create any significant increases in overall plant noise exposures at the NSRs.

3.4 *LANDSCAPE AND VISUAL IMPACTS*

This assessment considered the combined impacts of both the existing and proposed HEC power stations.

Views from many of the smaller villages and recreation areas on the island will be largely impeded by the existing power station. Even the partial views that are available from some locations are not considered to have significant adverse impacts, as the existing station is larger and closer to viewers. For some of the more distant viewers, only the tops of the new chimneys will be visible. For others the intervening distance and the existing visual character of the area (which is dominated by the existing power station) will reduce the expected impacts to an acceptable level, with the implementation of the recommended mitigation measures such as sensitive arrangement of site, buildings & structures, use of colours on buildings & landscaping.

3.5 *MARINE ECOLOGY*

The assessment of indirect impacts on marine ecological resources during the construction phase for the project was based on the predicted cumulative impacts on water quality (especially SS levels) of the proposed Lamma extension reclamation and other projects, such as construction work on CT9 and winning and dumping activities and the South Tsing Yi Marine Borrow Area. The assessment concluded that, provided water quality mitigation measures are implemented and water quality objectives are met, impacts on marine ecology would be acceptable.

3.6 *FISHERIES*

As with marine ecology, the assessment of indirect impacts on fisheries resources was based on the predicted cumulative impacts on water quality of the proposed Lamma extension reclamation and other projects. This assessment also concluded that, provided water quality objectives are met, predicted impacts on fisheries would be acceptable.

3.7 *HAZARDS*

The assessment of cumulative impacts in respect of the hazards associated with the new power station considered the following:

- possible hazardous interactions between the existing Lamma Power Station and the Lamma Extension;

- possible hazardous interactions between the fuel gas and non-fuel gas facilities at the Lamma Extension (ie incidents associated with the storage and handling of non-fuel gas dangerous goods which could escalate to involve the fuel gas facilities); and

- cumulative risks due to the fuel gas and non-fuel gas facilities at the Lamma Extension.

A number of potential hazardous interactions were analysed, including:

- a major fire or explosion at the dangerous goods store which could impact the fuel gas facilities through missile damage;

- major failure of high pressure equipment or rotating machinery which could also result in missile damage; and

- the impacts of coal fires and other possible events associated with coal handling and use at the existing Lamma Power Station.

The assessment concluded that the possibility of incidents at the fuel gas facilities being initiated by events at the existing Lamma Power Station was remote, because of the physical separation of the fuel gas facilities from the existing power station. It was considered possible that missiles generated by failure of pressure vessels or catastrophic failure of rotating machinery might travel this distance, but the risks associated with such incidents were expected to be low. These interaction hazards would be considered further in the detailed risk assessment required by GSO for the fuel gas facilities at the Lamma Extension.

In respect of the cumulative risks due to the fuel gas and non-fuel gas facilities at the Lamma Extension, the assessments which have been undertaken indicate that these will be acceptable.

The potential cumulative impacts associated with the construction and operation of the Lamma Extension development have been assessed as an integral part of the individual technical assessments undertaken in the EIA Report. No insurmountable or unacceptable cumulative impacts were identified in these assessments, provided that the recommended mitigation measures are implemented. In addition, in some cases (such as the operational noise and fuel gas-related risk assessments) further assessment was recommended during the detailed design to confirm that these cumulative impacts are acceptable.

The cumulative assessment of the potential co-siting of the new power station with a Waste to Energy Incineration Facility (WEIF) has indicated that neither the cumulative air quality impacts nor the thermal discharge impacts would preclude the selection of Lamma as the site for the planned WEIF. However, further cumulative assessments on the remaining environmental issues would be required, as part of the EIA of the WEIF, if the Lamma Site was selected as the preferred option for the facility.